INFLUENCE OF SOIL MANAGEMENT SYSTEMS ON THE MICROFUNGAL COMMUNITIES OF POTATO FIELD

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ABSTRACT - Soil microflora of three systems was estimated for two crop cycles. Maximum fungal propagules were recorded in valley land soil followed by terrace land and slope land soils. Number of fungal propagules were higher in surface soil which decreased with increasing soil depth. A total number of 26, 21 and 27 species of fungi were isolated from valley land, terrace land and slope land respectively. *Mucor* spp., *Fusarium* spp., *Penicillium* spp. and *Trichoderma* spp. were dominant fungi in all the three systems. Similarity index of fungal species indicated that valley land was more similar to terrace land and differed markedly from slope land.

RÉSUMÉ - Estimation de la microflore du sol de 3 systèmes agricoles différents sur 2 cycles de récolte. Le maximum de propagules fongiques est enregistré dans le sol de vallée, il est suivi par les sols de culture en terrasse puis de versant. Le nombre de propagules est plus élevé en surface et décroît avec la profonduer du sol prélevé. 26, 21 et 27 espèces de champignons ont été isolés respectivement des systèmes vallée, culture en terrasse et versant. Les *Mucor, Fusarium, Penicillium* et *Trichoderma* sont dominants dans les 3 systèmes. Des indices de similarité indiquent que le système vallée est plus proche de la culture en terrasse et diffère fortement du système versant.

KEY WORDS : microfungal communities, succession.

INTRODUCTION

Soil is impregnated with a variety of heterotrophic microorganisms. In soil, fungi and bacteria are responsible for breakdown of organic matter and release of nutrients. They are also known to be responsible for nutrient transformation, particularly in the case of nitrogenous and phosphatic minerals. Fungi are most important primary consumers of decomposable materials of soil. Soil not only provides a very conductive habitat for fungi, but a major part of soil microbial biomass is comprised of fungi. Clark & Paul (1970) reported about twice as much fungal biomass as bacterial biomass. Soil microflora thus exerts considerable influence on the soil fertility and plant growth. In agricultural soils, ploughing, tillage, application of fertilizers and biocides and type of cultivation affect the microorganisms. The plant species growing on the soil also exert very important influence on the population and species composition of the soil fungi (Mishra & Sharma, 1977).

A number of studies on soil microorganisms have been carried out on forest and grassland soils (Mishra, 1966; Christensen, 1969; Lewis et al., 1971; Widden, 1979). Microbiological studies of agricultural soil have received less attention (Domsch & Gams, 1972; Soderstrom et al., 1983). Present study deals with the effect of different agricultural systems on the succession of fungal communities in potato field soil for two crop cycles.

MATERIALS AND METHODS

The study was carried out at Upper Shillong (altitude 1706-1730m, latitude 25°34″ and longitude 91°56″E) in east Khasi Hills District of Meghalaya, India. The climate of the area is subtropical and can be divided into four marked seasons - (i) a summer season of heavy rainfall (May-September), (ii) a transitional period of mild temperature and low rainfall (October-November), (iii) a winter season (December-February), (iv) windy spring (March-April). Annual precipitation during the study period was 1570mm and the most rainfall occurred between April and September. The average minimum and maximum temperature of the study site was 1.0°C and 23°C respectively. The top soil is

Table 1. Moisture content (MC), pH, Organic carbon (C), total nitrogen (N), available phosphorus (P) and exchangeable potassium (K) of soils of different agriculture systems (Data are mean of three depths 10, 20 and 30cm for two years 1985-1986).

Tableau 1: Teneur en humidité (MC), pH, carbone (C), azote (N), phosphore (P) et potassium (K) des sols des différents systèmes agricoles (moyenne des 3 profondeurs pour les 2 années 1985-1986).

Sampling date	UPLAND						TERRACE LAND					
	MC	pH	C	N	P	K	MC	pH	C	N	P	K
10 Sep.	31.25	4.58	1.55	0.15	0.01	0.02	38.44	4.78	2.90	0.17	0.03	0.03
20 Sep.	32.04	4.67	1.39	0.16	0.01	0.02	37.42	4.27	2.87	0.18	0.04	0.04
30 Sep.	28.45	4.71	1.39	0.16	0.02	0.03	35.25	4.52	2.88	0.18	0.04	0.05
10 Oct.	30.57	4.71	0.92	0.16	0.02	0.04	34.21	4.70	2.68	0.19	0.05	0.05
20 Oct.	29.16	4.55	1.09	0.16	0.02	0.03	35.05	4.46	2.50	0.18	0.04	0.05
30 Oct.	25.55	4.80	1.29	0.16	0.01	0.03	30.80	4.72	3.02	0.18	0.04	0.05
10 Nov.	24.66	4.49	1.37	0.15	0.01	0.02	30.48	4.69	2.58	0.17	0.03	0.07
20 Nov.	24.41	4.45	1.56	0.14	0.01	0.02	30.70	4.68	2.44	0.17	0.03	0.04
L.S.D. (P: 0.05)	04.51	0.46	0.94	0.05	0.002	0.004	03.82	0.51	1.94	0.06	0.004	0.005

Sampling date	VALLEY LAND					
	MC	pH	C	N	P	K
10 Sep.	42.73	4.50	3.00	0.21	0.04	0.01
20 Sep.	41.28	4.30	3.42	0.22	0.04	0.01
30 Sep.	40.63	4.40	2.96	0.22	0.04	0.02
10 Oct.	41.13	4.55	3.10	0.23	0.06	0.02
20 Oct.	42.68	4.35	3.28	0.22	0.05	0.02
30 Oct.	37.15	4.57	3.54	0.21	0.04	0.02
10 Nov.	38.45	4.26	3.59	0.20	0.04	0.02
20 Nov.	38.28	4.24	3.74	0.20	0.03	0.01
L.S.D. (P: 0.05)	05.21	0.47	2.89	0.05	0.004	0.004

sandy loam (sand 72%, silt 10% and clay 18%). Physico-chemical characteristics of different agricultural systems are given in table 1.

The soil samples were collected from potato fields under three different management systems. In one type farmers adapt slash and burn type of shifting cultivation mostly on the hillocks (slope land). The second type is done on bench terraces built on hill slopes. Between the hillocks some plain lands are found and on such lands permanent type of cultivation is done which is known as valley land. Sampling was done at ten days interval for two crop cycles from 10th September, 1985 to 20th November, 1985 and 10th September, 1986 to 20th November, 1986. Soil samples were collected from three depths (0-10, 10-20, and 20-30cm). The data correspond to mean of three replicate analysis of a mixed sample collected from five random sites in each field.

Soil plate method was used to assess fungal populations. Martin's rose bengal agar medium was used for the isolation of fungi (Johnson & Curl, 1972). The inoculated agar plates were incubated at 25°C and colonies were counted after five days. Similarity index was calculated by following Sorenson's (1948) model.

$$\textit{Similarity index } (\%) = \frac{2C}{A+B} \, x100$$

where A means total number of species in one system, B means total number of species in second system and C means total number of species common in both the systems.

Organic carbon, total nitrogen, available phosphorus and exchangeable potassium were determined by the Walkley & Black's method (1934), semi-micro Kjeldahl method (Allen, 1974), sulphomolybdic acid method and flame photometer method (Jackson, 1973) respectively. pH was measured in soil and in water mixture (1:5) using an electrical pH meter. Moisture content was assessed by oven dry method at 105°C. Statistical analysis of data was done by performing Lattice Square Design (LSD), which determines the significance of apparent difference in number of fungal propagules among soils from the different systems, with soil depth, and the significant changes in soil physico-chemical properties.

RESULTS AND DISCUSSION

Temporal and depthwise variation in fungal population of soils of three systems is given in Figure 1. The numbers of fungal propagules per gram dry soil were maximum in valley land soil and minimum in slope land soil. In depth wise studies fungal population was always highest in surface soil and decreased along with soil depth. In all the three systems highest fungal population was found in October, which was followed by a sharp decline (Fig. 1).

Decrease in fungal population along soil depth confirms the findings of Soderstrom (1975), Bisset & Parkinson (1979), Deka & Mishra (1984). Surface soil is usually provided with high organic matter content which in presence of adequate moisture supply is acted upon by microorganisms to decompose the complex organic residues into simpler forms, hence the microorganisms are higher on surface layer of the soil (Mishra & Kanaujia, 1972; Acea & Carballas, 1985). Generally, fungi found in deeper layer are slow growing due to unavailability of mineral nutrients and compaction of soil along depth (Saxena & Sarbhoy, 1963; Mishra, 1966; Dkhar, 1983). In the month of October at the

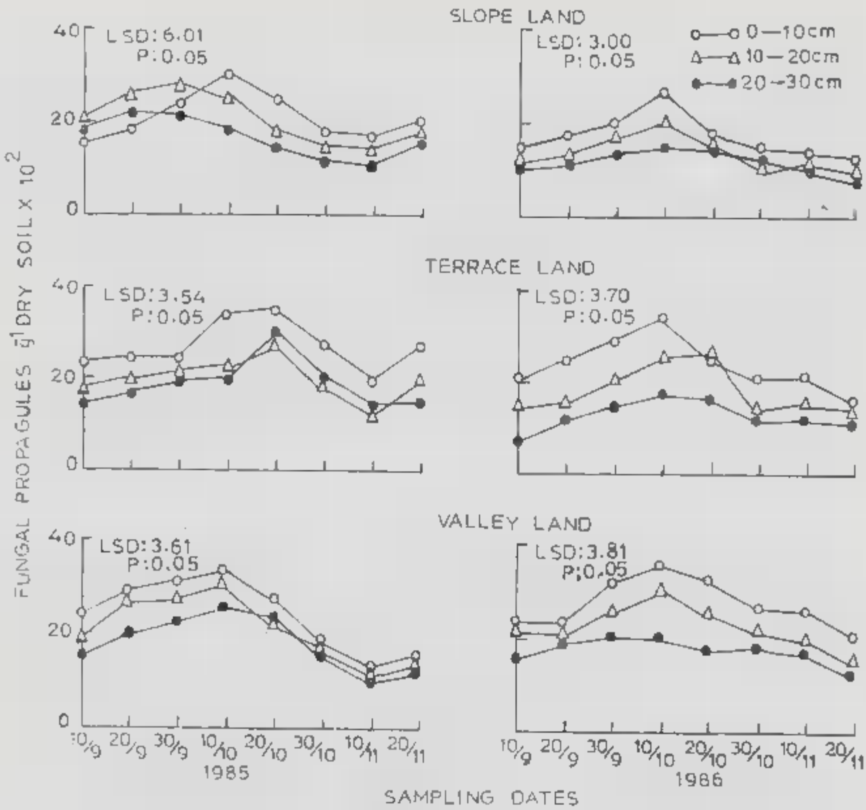

Fig. 1. - Number of fungi (fungal propagules) in different agricultural systems of potato field soil.

Fig. 1. - Nombre de champignons (propagules) dans différents systèmes agricoles de sol de culture de pomme de terre.

middle age of plants, high fungal population in deeper layer may be due to possible increase in root exudation (Rovira, 1956; Hassink et al., 1991). The maximum number of fungal propagules in valley land soil might be due to high concentration of organic carbon, nitrogen, phosphorus and potassium as compared to terrace and slope lands (Shukla et al., 1989).

A total number of 26 species were isolated from valley land soil. *Absidia glauca*, *Rhizopus oryzae* and *Emmonsiella capsulata* were isolated only from the surface layer (0-10cm) of soil, while *Alternaria alternata* and *Phoma* sp. were isolated only from the middle layer (10-20cm). *Monilia* sp., *Penicillium funiculosum* and *Trichoderma harzianum* were isolated only from 20-30cm depth soil. *Fusarium* sp., *Mucor hiemalis*, *M. racemosus*, *P. brevicompactum*, *P. chrysogenum* and *T. viride* were common at all the three depths of valley land soil (Table 2).

Twenty one species were isolated from terrace land soil. *A. alternata*, *Humicola fuscoatra* and *P. fellutanum* were restricted only to surface (0-10cm) soil. *Penicillium canescens* and *Pythium* sp. were isolated only from 20-30cm depth soil. *Aspergillus flavus*, *Fusarium poae*, *M. hiemalis*, *M. plumbeus*, *M. racemosus*, *P. chrysogenum*, *P. brevicompactum* and *T. viride* were common fungi in all the three depths of terrace land soil (Table 3).

Table 2. - Fungal species per gram dry soil x 10^2 (mean of collection in respective months) at different depths for two crop cycles (1985-1986) in valley land soil.

Tableau 2. - Espèces fongiques par gramme de sol sec (x 10^2) aux différentes profondeurs et pour 2 cycles de récolte (1985-1986) en sol de vallée.

	(10-30 Sep.)			(10-30 Oct.)			(10-20 Nov.)		
Fungi	10cm	20cm	30cm	10cm	20cm	30cm	10cm	20cm	30cm
Absidia glauca Hagem	2.2	-	-	-	-	-	1.9	-	-
Alternaria alternata (Fr.) Keissler	-	-	-	-	2.1	-	-	-	-
Aspergillus alutaceus Berk. & Curt.	-	-	1.2	-	-	-	-	-	-
Aspergillus flavus Link: Fries	-	2.1	2.5	-	3.2	3.2	-	-	-
Aspergillus niger V. Tiegh.	-	-	-	2.4	4.7	1.0	-	-	-
Emmonsiella capsulata Kwon-Chung	5.5	-	-	-	-	-	-	-	-
Fusarium oxysporum Schlecht em. Sny. & Hans.	5.4	4.2	3.2	-	-	-	-	3.0	-
Fusarium poae (Peck) Wollenw.	-	4.9	3.4	8.5	-	7.4	-	-	-
Fusarium solani (Mart.) Sacc.	-	-	1.2	-	5.5	-	2.0	-	-
Monilia sp.	-	-	1.1	-	-	-	-	-	-
Mortierella minutissima V. Tiegh.	6.5	4.3	-	6.2	5.0	2.1	-	2.0	-
Mucor circinelloides V. Tiegh.	-	-	-	-	-	-	5.4	-	5.1
Mucor hiemalis Wehmer	3.3	3.6	2.1	4.4	4.0	3.3	-	3.0	3.2
Mucor plumbeus Bonord.	2.2	4.5	4.0	3.9	7.1	2.9	5.6	2.1	2.4
Mucor racemosus Fres.	7.6	4.9	5.3	10.9	8.7	3.4	4.0	5.7	2.4
Penicillium brevicompactum Dierckx	3.3	-	-	7.8	4.4	-	7.0	3.2	-
Penicillium chrysogenum Thom	9.7	3.6	4.0	2.2	6.4	6.3	-	4.4	2.1
Penicillium fellutanum Biourge	-	4.3	3.2	-	-	-	-	2.6	-
Penicillium funiculosum Thom	-	-	1.9	-	-	-	-	-	-
Phoma sp.	-	3.2	2.2	-	4.4	-	-	-	-
Rhizopus oryzae Went & Prinsen	3.2	-	-	-	-	-	-	-	-
Trichoderma harzianum Rifai	-	-	2.5	-	-	-	-	-	4.1
Trichoderma viride (Pers.) Gray	4.3	5.7	3.2	3.1	2.1	3.4	4.7	-	4.2
Sterile white	2.3	6.2	2.2	3.6	5.5	7.6	5.4	4.4	3.0
Sterile yellow	3.2	3.2	2.1	4.5	2.2	1.2	4.0	2.3	2.1

Twenty seven species were isolated from slope land soil. *Arthrobotrys arthrobotryoides*, *Oidiodendron echinulatum*, *P. canescens*, *P. citrinum* and *Phoma* sp. were isolated only from middle layer (10-20cm) of soil, while *Rhizopus oryzae*, *T. koningii* and *Verticillium chlamydosporum* were isolated only from 20-30cm depth soil. *Aspergillus flavus*, *M. hiemalis*, *M. plumbeus*, *M. racemosus*, *F. oxysporum*, *P. chrysogenum*, *P. brevicompactum* and *T. viride* were common in all the three depths (Table 4).

The effect of temperature and moisture could not be separated for *Absidia corymbifera*, *H. fuscoatra* and *Pythium* sp. in terrace land where combined temperature and moisture were high. *Absidia glauca*, *Aspergillus alutaceus* and *Emmonsiella capsulata* appeared to be adapted to high moisture content (Baruah, 1983) and were found in the valley land. *Trichoderma koningii* appeared in the last phase of the study when both temperature and moisture were low. Dowding & Widden (1974) concluded that pH, temperature and moisture were the most important factors affecting the composition of mycoflora over 21 arctic and alpine tundra sites. The genus *Aspergillus* is extremely common in subtropical soils (Saxena & Sarbhoy, 1963). *Verticillium chlamydosporum* and *Verticillium* sp. had a very restricted distribution and were isolated twice only in slope and terrace land, showed an extremely aggregated pattern of distribution. Species with high colonization densities usually had comparatively high communities. *F. oxysporum*, *M. plumbeus*, *M. racemosus*, *P. brevicompactum*, *P. chrysogenum* and *T. viride* were the common fungi in all the fields. Species of

Mucor, *Penicillium* and *Trichoderma* seem to be tolerant to [illegible] wider range of environmental conditions. Mishra & Kanaujia (1973) isolated more diverse microflora from cultivated soil as compared to grassland and forest soils and they found that *M. hiemalis*, *A. flavus*, *A. niger*, *P. chrysogenum* and *Cladosporium herbarum* were the most dominant fungi. Species of *Penicillium*, *Fusarium*, *Mucor* and *Trichoderma* were also dominant fungi in maize (Dkhar, 1983) and rice fields (Baruah, 1983) due to cold climate and acidic nature of soils of the region. For a given community, it is generally observed that one or a few species are numerically predominant and may strongly affect environmental conditions for other species (Durall & Parkinson, 1991; Wardle & Parkinson, 1991). In the present study, few species were regularly isolated at relatively high frequencies. These species also had the most wide-spread and least aggregated distributions. The low levels of aggregation observed for these species may reflect a relatively broad or diverse niche space that may be the result of successful adaptation to many dimensions in the system.

Table 3. - Fungal species per gram dry soil x 10^2 (mean of collection in respective months) at different depths for two crop cycles (1985-1986) in terrace land soil.

Tableau 3. - Espèces fongiques par gramme de sol sec (x 10^2) aux différentes profondeurs et pour 2 cycles de récolte (1985-1986) en sol de culture en terrasse.

	(10-30 Sep.)			(10-30 Oct.)			(10-20 Nov.)		
Fungi	10cm	20cm	30cm	10cm	20cm	30cm	10cm	20cm	30cm
Alternaria alternata (Fr.) Keissler	1.0	-	-	-	-	-	-	-	-
Absidia corymbifera (Cohn) Sacc. & Trotter	-	3.2	2.2	2.1	3.3	-	-	-	-
Aspergillus flavus Link: Fries	-	-	1.0	5.2	1.1	2.2	-	-	2.0
Aspergillus niger V. Tiegh.	-	-	-	4.2	5.4	2.9	7.5	5.7	2.7
Fusarium oxysporum Schlecht em. Sny. & Hans.	5.2	2.5	3.3	3.8	2.7	-	2.7	-	-
Fusarium poae (Peck) Wollenw.	5.1	3.1	-	4.1	3.1	5.5	3.6	2.7	-
Fusarium solani (Mart.) Sacc.	-	-	3.1	-	-	2.3	-	-	-
Humicola fuscoatra Traaen	2.1	-	-	-	-	-	2.5	-	-
Monilia sp.	-	2.1	1.0	3.8	2.9	2.9	3.8	2.8	2.9
Mortierella minutissima V. Tiegh.	-	2.2	-	-	2.0	-	1.9	-	-
Mucor circenelloides V. Tiegh.	-	-	-	2.7	-	-	-	4.8	-
Mucor hiemalis Wehmer	3.1	-	2.0	3.8	1.0	2.2	-	-	-
Mucor mucedo Linnaeus: Fries	2.1	2.9	3.2	-	-	1.9	-	-	-
Mucor plumbeus Bonord.	3.9	-	1.1	7.8	4.6	2.8	2.9	3.0	4.6
Mucor racemosus Fres.	9.5	4.9	3.2	2.0	-	3.2	2.6	1.9	-
Penicillium brevicompactum Dierckx	3.2	2.1	2.2	5.[illegible]	7.9	2.9	2.9	4.5	4.7
Penicillium canescens Sopp	-	2.1	-	-	-	3.9	-	-	-
Penicillium chrysogenum Thom	8.7	6.3	4.8	5.2	4.0	-	4.8	2.0	2.9
Penicillium fellutanum Biourge	2.1	-	-	9.1	-	-	4.7	-	3.0
Phoma sp.	-	-	-	-	-	-	-	-	1.9
Pythium sp.	-	-	-	-	-	-	-	1.9	-
Trichoderma harzianum Rifai	-	2.1	1.1	-	-	-	-	-	-
Trichoderma viride (Pers.) Gray	7.9	7.8	3.2	4.1	1.9	-	3.9	-	2.1
Verticillium sp.	-	-	-	-	-	3.0	-	-	3.0
Sterile	2.2	1.3	-	2.9	2.7	2.9	-	2.7	1.9

The majority of the taxa showed change in quantity with soil depth. In agriculture system, widely changes in community structure take place at the surface layer. At greater depth, differences of distribution level or patterns are usually reversed according to the prevailing conditions (water, potential oxygen and substrate availability) at various intervals after the respective operations (Domsch, 1986). It is clear from the results that systems differed from one another as far as soil nutrients are concerned. It has been demonstrated that the occurrence of fungal species depend upon soil type, soil moisture, mineral nutrition and temperature (VanVuurda & Schippers, 1980). The major elements essential for germination of fungal propagules in soil are nitrogen, carbon and iron (Benson & Baker, 1970; Kloepper et al., 1980). An estimation of the influence (positive or negative) of man's activities ranks the impact on some natural soil properties in the following order, structure = aeration = pH = nutrient status = toxic substances > depth of arable layer = water status = organic matter content = soil organisms > sorption capacity = humus quality (Sauerbeck, 1985).

Table 4. - Fungal species per gram dry soil x 10^2 (mean of collection in respective months) at different depths for two crop cycles (1985-1986) in slope land soil.

Tableau 4. - Espèces fongiques par gramme de sol sec (x 10^2) aux différentes profondeurs et pour 2 cycles de récolte (1985-1986) en sol de versant.

	(10-30 Sep.)			(10-30 Oct.)			(10-20 Nov.)		
Fungi	10cm	20cm	30cm	10cm	20cm	30cm	10cm	20cm	30cm
Absidia corymbifera (Cohn) Sacc. & Trotter	3.1	2.4	2.8	2.1	3.4	-	-	2.1	1.5
Arthrobotrys arthrobotryoides (Berl.) Lindau	-	-	-	-	-	11.6	-	-	-
Aspergillus flavus Link: Fries	-	4.5	0.9	-	2.6	1.7	-	-	-
Aspergillus niger V. Tiegh.	-	0.9	-	16.8	4.2	-	-	-	-
Fusarium oxysporum Schlecht em. Sny. & Hans.	4.4	11.5	5.7	8.7	2.4	3.5	-	-	-
Fusarium poae (Peck) Wollenw.	-	-	-	1.7	-	-	-	-	-
Fusarium solani (Mart.) Sacc.	-	-	-	3.8	6.4	-	-	-	-
Monilia sp.	-	1.5	2.7	-	1.6	1.8	2.4	1.6	-
Mortierella minutissima V. Tiegh.	-	1.9	2.7	-	2.6	4.7	-	-	-
Mucor hiemalis Wehmer	-	-	1.9	3.9	3.6	1.8	7.5	7.2	4.9
Mucor plumbeus Bonord.	5.3	10.6	6.8	5.0	10.1	6.2	3.7	1.7	2.3
Mucor racemosus Fres.	5.1	5.2	5.2	4.5	4.8	2.9	6.5	6.2	7.2
Oidiodendron echinulatum Barron	-	0.9	-	-	-	-	-	-	-
Penicillium brevicompactum Dierckx	-	2.6	1.9	1.7	-	-	-	1.9	3.2
Penicillium canescens Sopp.	-	1.9	-	-	-	-	-	-	-
Penicillium chrysogenum Thom	3.4	6.1	7.8	2.5	5.2	-	3.5	3.5	2.0
Penicillium citrinum Thom	-	3.2	-	-	-	-	-	-	-
Penicillium fellutanum Biourge	-	-	-	-	2.5	1.7	-	-	2.1
Phoma sp.	-	-	-	-	8.6	-	-	-	-
Rhizopus oryzae Went & Prinsen	-	-	-	-	-	2.8	-	-	-
Trichoderma hamatum (Bon.) Bain.	-	1.5	1.9	-	-	-	-	-	0.7
Trichoderma harzianum Rifai	3.8	7.8	1.8	5.6	2.4	8.0	-	6.8	-
Trichoderma koningii Oudem.	-	-	-	-	-	1.7	-	-	-
Trichoderma viride (Pers.) Gray	5.0	-	7.8	5.0	5.8	8.2	2.2	2.2	1.8
Verticillium sp.	-	-	-	3.7	-	-	-	-	-
Verticillium chlamydosporum Goddard	-	-	3.8	-	-	-	-	-	-
Sterile	3.4	-	1.9	5.2	-	3.1	2.9	-	-

Similarity index of fungal communities of different systems at different depths was calculated (Table 5). In valley land, fungal species composition of 0-10cm depth was similar to 10-20cm depth (68%) and 10-20cm was similar to 20-30cm depth (78%), while 0-10cm was less similar to 20-30cm depth (64%). In terrace land there was no marked difference in fungal species composition of the three depths or soils. In slope land soil 0-10cm depth was more similar to 20-30cm depth as compared to 10-20cm depth. When the fungal communities of 0-10cm depths of the three management systems were compared, it was found that similarity index among three systems varied between 66 and 70%, while at 10-20cm depths it varied between 50 and 70% and in 20-30cm depths the variation was between 61 and 75%. Among all the three systems it was noted that the species composition of the valley land was more similar to terrace land and it differed markedly from slope land soils. Taking similarity index of the fungal community as an index of homogeneity of habitat (Clarke & Christenson, 1981), it may be suggested that soil up to a depth of 30cm was almost homogeneous. However, same does not hold true when we look at the population of fungi (Fig. 1). It appears that during digging or ploughing the soil is mixed, thus the fungal species are distributed almost uniformly upto the depth studied. Also it may be inferred that most species were capable of colonizing the soil up to 30cm depth of soil.

Table 5. - Comparison of soil fungi using model of Sorenson (1948) for similarity index (%) at different depths and in different systems.

Tableau 5. - Comparaison des champignons de sol en utilisant le modèle de Sorenson (1948) pour les indices de similarité (%) aux différentes profondeurs et pour les différents systèmes agricoles.

Slope land (SL)	Terrace land (TL)	Valley land (VL)
10cm x 20cm = 84	10cm x 20cm = [illegible]	10cm x 20cm = 58
10cm x 30cm = 91	10cm x 30cm = 78	10cm x 30cm = 64
20cm x 30cm = 58	20cm x 30cm = 73	20cm x 30cm = 78

10cm	20cm	30cm	Different systems
VL x TL = 68	VL x TL = 55	VL x TL = 79	VL x TL = 73
TL x SL = 70	TL x SL = 70	TL x SL = 71	TL x SL = 71
VL x SL = 66	VL x SL = 65	VL x SL = 61	VL x SL = 67

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